5. **Calpuff Modeling - Visibility**

Given predicted exceedances of PSD Class I increments, the MRY station Calpuff analysis was extended to include preliminary assessment of visibility impact (light extinction) at Class I areas. The visibility analysis addressed MRY station impact, only, for one year of Calmet processed meteorological data.

Guidance from the Interagency Workgroup on Air Quality Modeling[4] (IWAQM) and from the National Park Service (Appendix D) was utilized for the visibility analysis.

5.1 <u>Source Data</u>

The Calpuff visibility analysis addressed proposed increases in emissions of SO_2, NO_x, coarse particulate (>2.5 microns) and fine particulate (<2.5 microns) at MRY station. To preserve integrity of the Calpuff treatment of chemistry, it was concluded inappropriate to model simply the increase in emissions. Rather, separate Calpuff runs were executed for the "before" emissions increase scenario and the "after" emissions increase scenario. Daily light extinction for both scenarios was calculated using Calpost, and the difference in Calpost results for the two scenarios was used to derive percentage increase in light extinction.

The MRY station emission inventory for both "before" and "after" scenarios is provided in Table 5-1. Emission rates reflect appropriate values for 24-hour averages.

5.2 <u>Receptor Locations</u>

Class I area receptor locations used for the MRY station visibility analysis were consistent with those used for the PSD increment analysis (Section 4.2, Figures 4-2 and 4-3).

5.3 <u>Calpuff Execution and Postprocessing</u>

Calpuff was executed for both "before" and "after" emission scenarios discussed in Section 5.1, using 1992 meteorological data developed as described in Section 2. Settings for Calpuff control file options/parameters were consistent with those utilized for the Class I increment analysis (Section 4.3).

The modeled component of light extinction accounted for the effect of sulfate, nitrate, coarse particulate (PM_{10} >2.5 microns), and fine particulate (PM_{10} <2.5 microns). Seasonal values for background light extinction were provided by the National Park

Table 5-1
Source Inventory for Visibility Analysis

Source No.		X Coordinate (km)	Y Coordinate (km)	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Vel. (m/s)	Exit Temp. (deg. K)	Bldg. Dwash	Emission Rates (SO2,SO4,NOx,HNO3,NO3,PMC,PMF)
1	! SRCNAM = Milton R Young Station Unit 1 (before) !									
1	! X =	59.519,	341.409,	91.4,	597.4,	5.8,	21.3,	455.0,	0.,	945.0, 0.0, 353.2, 0.0, 0.0, 1.4, 1.4 !
2	! SRCNAM = Milton R Young Station Unit 2 (before) !									
2	! X =	59.462,	341.356,	167.6,	597.4,	7.6,	20.3,	347.0,	0.,	710.0, 0.0, 437.2, 0.0, 0.0, 14.8, 14.8 !
3	! SRCNAM = Milton R Young Station Unit 1 (after) !									
3	! X =	59.519,	341.409,	91.4,	597.4,	5.8,	21.3,	455.0,	0.,	1209.6, 0.0, 362.9, 0.0, 0.0, 10.1, 10.1!
4	! SRCNAM = Milton R Young Station Unit 2 (after) !									
4	! X =	59.462,	341.356,	167.6,	597.4,	7.6,	20.3,	347.0,	0.,	952.6, 0.0, 873.2, 0.0, 0.0, 19.8, 19.8 !

Service (Appendix D) for the Class I areas involved in the MRY station analysis (the values were equivalent for all Class I areas). These background extinction values included a hygroscopic component and a non-hygroscopic component, which included the effects of Rayleigh scattering. Using results from the "before" and "after" Calpuff runs, percentage increase in light extinction due to the proposed emissions increase at MRY station was calculated as follows:

$$Percent\ change = \frac{b_{source-after} - b_{source-before}}{b_{back}} (100\%)$$

Where:

$b_{source-after}$ = modeled light extinction due to MRY "after" scenario

$b_{source-before}$ = modeled light extinction due to MRY "before" scenario

b_{back} = background light extinction based on values provided by NPS

The calculation was made on a daily (24-hour average) basis. Note that the calculated value is the percentage change with respect to calculated background values.

In calculating increase in light extinction, it was indicated by the NPS that the relative humidity adjustment factor f(RH) for modeled and background components should "cancel out". That is, background values should incorporate the same daily f(RH) values applied by the model. This was achieved by executing Calpost specifically for generating daily background light extinction. Option MVISBK (method used for background light extinction) was set to 1. The BEXTBK parameter (background light extinction) was set to an adjusted version of the background provided by the NPS. The adjustment involved recalculating the background with f(RH) set to 1.0. This was necessary because Calpost applies its own daily f(RH) when calculating daily background. Parameter RHFRAC (percentage of particles affected by relative humidity) was set to the portion of the modified NPS background which is due to hygroscopic particles. Because the NPS provided different background values for each season, Calpost was executed separately for each season to determine daily background light extinction. The background information provided by the NPS, along with the Calpost input values for BEXTBK and RHFRAC, is summarized in Table 5-2.

Table 5-2
NPS Background Extinction and Calpost Input Values*

	NPS Background Extinction (1/Mm)				Calpost Input	
	Non-Hygroscopic		Hygroscopic	Total	BEXTBK	RHFRAC
	Rayleigh	Other			(1/Mm)	(%)
Winter	10.0	4.02	1.03	15.05	15.05	6.8
Spring	10.0	5.30	1.65	16.95	16.95	9.7
Summer	10.0	8.85	2.72	21.57	21.57	12.6
Fall	10.0	5.36	1.44	16.80	16.80	8.6

* Values are equivalent for all Class I areas modeled.

To accommodate the NDDH methodology for modeled and background light extinction, a modification to Calpost was required. When MVISBK is set to 1, Calpost (Version 5, Level 981116) determines f(RH) using IWAQM (1993) curves rather than the more recent IMPROVE (1996) table. A coding change was made which forces Calpost to use the IMPROVE table (which Calpost uses for other MVISBK options) for MVISBK option 1. This coding change is described in Appendix E.

When Calpost runs were completed for the "before", "after", and background scenarios, appropriate columns from the Calpost "24 HR VISIBILITY" tables were exported to "after", "before", and "background" columns in a spreadsheet. The "background" column had to be created piecemeal, as several Calpost runs were involved for different seasons. The spreadsheet was used to calculate daily increases in light extinction, and to summarize the frequency of occurrence greater than a threshold level (i.e., 5 percent of background).

The described procedure was repeated for each Class I area.

5.4 Results

Results of the Calpuff analysis of visibility impact from proposed emission increases at the Minnkota MRY station are summarized in Table 5-3 and Figure 5-1. Table 5-3 summarizes highest daily (24-hour average) increase in light extinction at each Class I area, and the number of days during the year (1992) that the increase exceeded 5 percent of the background. A time series plot of the modeled change in light extinction at Lostwood Wilderness Area for 1992 is illustrated in Figure 5-1.

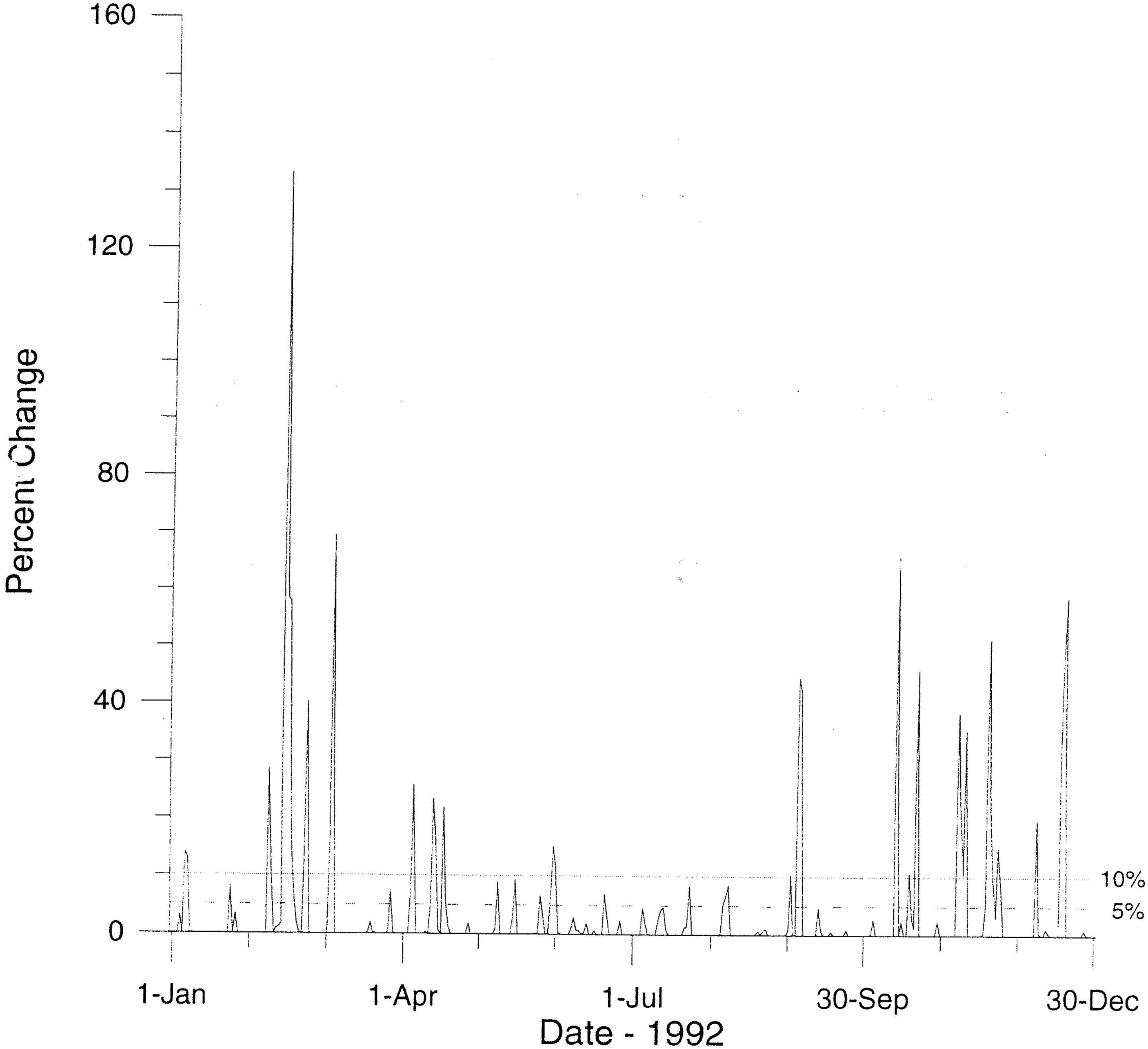
As shown in Table 5-3, maximum predicted impact on visibility was found at the Lostwood Wilderness Area. The proposed increase in MRY station emissions resulted in a 133 percent increase in light extinction on the worst-case day. The number of days where the predicted increase exceeded 5 percent at Lostwood was 52. Complete daily results for the MRY station visibility analysis can be found in the spreadsheet (Quattro-Pro) included in the computer media accompanying this report.

The time series plot in Figure 5-1 illustrates the frequency with which the 5 percent threshold is exceeded, and the seasonal variation in light extinction change at Lostwood Wilderness Area. Highest predicted impacts on visibility appear to occur in the fall and winter (in 1992).

Table 5-3
Change in 24-hour Average Light Extinction
Compared to Background
(1992 Met. Data)

	TRNP	Lostwood W. Area	Medicine Lake/ Fort Peck
Maximum Increase	66%	133%	94%
No. Days >5%	43	52	26
No. Days >10%	28	34	18

Figure 5-1: Predicted Change in 24-hour Average Light Extinction At Lostwood Wilderness Area



6. **Summary**

The Calpuff modeling system has been implemented by the NDDH. Extensive testing and a performance evaluation have been conducted to determine the utility of the NDDH implementation. The NDDH Calpuff modeling system has been applied for the Milton R. Young station permit application for proposed increase in ambient pollutant emissions. Results of the modeling analysis indicate numerous predicted exceedances of PSD Class I increments, and that Milton R. Young station will significantly contribute to many of these exceedances. Results of the modeling analysis also indicate that the proposed increase in emissions at Milton R. Young, alone, may adversely impact visibility at nearby Class I areas.

7. References

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